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7. ABBREVIATIONS AND ACRONYMS

Below are a list of the abbreviations and acronyms used in this document.

CD ROM	-	Compact Disc Read Only Memory
COTS	-	Commercial Off-The-Shelf
ECS	-	EOSDIS Core System
E-mail	-	Electronic Mail
EOS	-	Earth Observing System
EOSDIS	-	Earth Observing System Data Information System
GB	-	Gigabytes
GOTS	-	Government Off-The-Shelf
GSFC	-	Goddard Space Flight Center
HAIS	-	Hughes Automated Information Services
IIR	-	Interactive Information Repository
IRD	-	Interface Requirements Document
IV&V	-	Independent Verification and Validation
IVVMP	-	Independent Verification and Validation Management Plan
ISV&VP	-	Independent System Verification and Validation Plan
Kbps	-	Kilobits per second
LAN	-	Local Area Network
M1	-	Milestone 1
M2	-	Milestone 2
MD	-	Maryland
MB	-	Megabytes
Mbps	-	Megabits per second
MHz	-	Megahertz
MS	-	Microsoft
NASA	-	National Aeronautics And Space Administration
PAR	-	Performance Assurance Requirements
PERT	-	Program Evaluation Review Technique
PC	-	Personal Computer
POC	-	Point Of Contact
PSCNI	-	Program Support Communication Network Interface
RAM	-	Random Access Memory
RDBMS	-	Relational Database Management System
RTM	-	Requirements & Traceability Management
SCSI	-	Small Computer System Interface
SOW	-	Statement Of Work
STD	-	Standard
TENDB	-	Transition Engineering Database
TBD	-	To Be Determined (at a later date)
WAN	-	Wide Area Network
WV	-	West Virginia
WVU	-	West Virginia University

6. FUTURE ACTIVITIES

With a basic set of capabilities in place, Task 4 will proceed to define and develop the M1 IV&V infrastructure and tools. Activities will be managed to give the highest priority to the needs of the SOW tasks with the most imminent deliverables (e.g., Task 5: Requirements Analysis and Traceability and Task 9: Key Interface Analysis). Tools and hardware required by these tasks will be given precedence.

Some PCs and printers have already been installed at the IV&V facilities in Fairmont, West Virginia and in Greenbelt, Maryland. However, most of the hardware elements specified in Table 5-1 remain to be purchased. With NASA's approval of the M1 hardware architecture, procurement will be initiated for these hardware elements, and the installation and checkout of the integrated networks for these two facilities will commence. Efforts to connect and checkout the LAN in Fairmont and the West Virginia- to-Maryland WAN will be closely coordinated with NASA.

MS Word, MS Powerpoint, MS Excel, and various other automated office tools are currently operational on PCs in Fairmont and Greenbelt. Other technical support tools are needed soon. The Interface Data Consistency Analyzer and the Transition Engineering Database, both developed in-house, have been proposed for the interface analysis, and they are currently available for use. The Requirements Traceability and Management Tool, a mature COTS tool, has been mandated for the requirements tracing task.

The efforts needed to acquire other tools vary in complexity and duration. The acquisition of tools for E-mail and file transfers will require some additional research to assess the IV&V system's requirements for these tools and to evaluate various COTS tools against these requirements. Selection and acquisition of these tools must and can be accomplished relatively quickly, and they will be needed to support communications as soon as the local and wide area networks are operational.

The language environment tools demand additional work to refine their requirements and to evaluate candidates from the numerous COTS tools on the market. Language environments must be acquired to support Ada, C, and Fortran.

The acquisition of some tools will be long term efforts, but these tools are not required until late in M1 or until the M2 tools are delivered in June 1996. The Integrated Information Repository and the "Test Buddy" fall into this category.

A status of the M1 infrastructure and tools will be presented at the M1 Initial Tool Architecture Review which is scheduled in August 1994. A demonstration of the M1 infrastructure and tools will be given two months later in October 1994. Subsequently, demonstrations of revisions to the M1 infrastructure and tools will be made in December 1994 and in June and December 1995.

Hardware Element, Location (Quantity)	Description	Function
Modem Server, Greenbelt (1) and Fairmont (1)	Netblazer	• Provide remote dial-in capability access to Unix Server and PC Server
Macintosh Computer, Greenbelt (2) and Fairmont (2)	TBD	• Personal computer for office automation software, desktop publishing, word processing, and electronic mail
Appletalk Bridge, Greenbelt (1) and Fairmont (1)	Telephone wire	• Provide network communication from thinnet backbone to Appletalk network
Appletalk Network, Greenbelt (1) and Fairmont (1)	Telephone wire	• Provide Network communication between Macintosh computers
10baseT ethernet LAN, Greenbelt (1) and Fairmont (1)	Twisted pair ethernet	• Provide network communication for PC and X-terminal clients to Servers through the thinnet backbone
thinnet backbone, Greenbelt(1) and Fairmont (1)	Thin Coaxial Cable	• Provide network communication between routers, servers, 10baseT ethernet LAN, and Macintosh network
PSCNI Router, Greenbelt (1)	To be supplied by NASA	• Provide connectivity for Greenbelt thinnet backbone to NASA PSCNI 56 Kbps line to GSFC
INTERMETRICS Corporate Network Router, Greenbelt (1)	Proteon P 4200	• Provide connectivity for Greenbelt thinnet backbone to INTERMETRICS Corporate Network
PSCNI Router, Fairmont (1)	To be supplied by NASA	• Provide connectivity for Fairmont thinnet backbone to NASA PSCNI T1 line to GSFC

Exhibit 5-3 M1 Hardware Description (continued)

Hardware Element, Location (Quantity)	Description	Function
Unix File Server, Fairmont (1)	SUN Sparc 1000 • 4.2 GB Hard Drive • 128 MB RAM • CD ROM • 4mm tape drive • SCSI buffered ethernet • sol12.x disk	• File server for the X window terminals • Support tool development • Processor for Unix based tools and applications • Central Repository for IV&V data, documentation, and information • Access control • Configuration management • Support Unix based communication across WAN
Unix File Server, Greenbelt (1)	SUN Sparc 20 • 2.1 GB HD • 64 MB RAM • CD ROM • 4mm tape drive • SCSI buffered ethernet • sol12.x disk	• File server for the X window terminals • Processor for Unix based tools and applications • Local Repository for IV&V data, documentation, and information • Access control • Support Unix based communication across WAN
X-terminal, Greenbelt (5) and Fairmont (8)	PhaseX • 20 inch color • 8 MB RAM • SUN5 Keyboard	• Terminal client for X-Window based applications
DOS PC, Greenbelt (12) and Fairmont (6)	Gateway P4D-66 • Intel 66 MHz 486 processor • 16 MB RAM • 450 MB HD • CD ROM • 17 inch color monitor	• Personal computer for office automation software, desktop publishing, word processing, and electronic mail • May serve as an X-Window client terminal
DOS PC Server, Greenbelt (1) and Fairmont (1)	Gateway P4D-66 • Intel 66 MHz 486 processor • 16 MB RAM • 1 GB HD • SCSI Controller • 17 inch monitor	• File server for DOS PCs • Processor for DOS based tools and applications • PC Access control • Support NOVELL based communication across WAN

Exhibit 5-3 M1 Hardware Description

M1 has no immediate need for **language environments** or **testing** tools. However, as M1 progresses, requirements will be identified and tools will be selected for these two important classes of tools.

Once again, the tools and their configurations, discussed here, support the requirements levied for M1. As new requirements arise and the project transitions to M2, the configuration and tools will be updated to support the changes.

5.3.2 Hardware Design

The EOSDIS IV&V M1 hardware architecture provides sufficient computational, storage, and communication capability to perform the IV&V tasks. The hardware needed to supply the distributed computational environment consists of a mix of file servers, PC's, Macintosh computers, and X-terminals linked together on a thinnet backbone and 10baseT ethernet LAN at both the Greenbelt and Fairmont facilities. Exhibit 5-2 contains a schematic for the M1 architecture. The specific hardware elements, their descriptions, and functions are provided in Table 5-1.

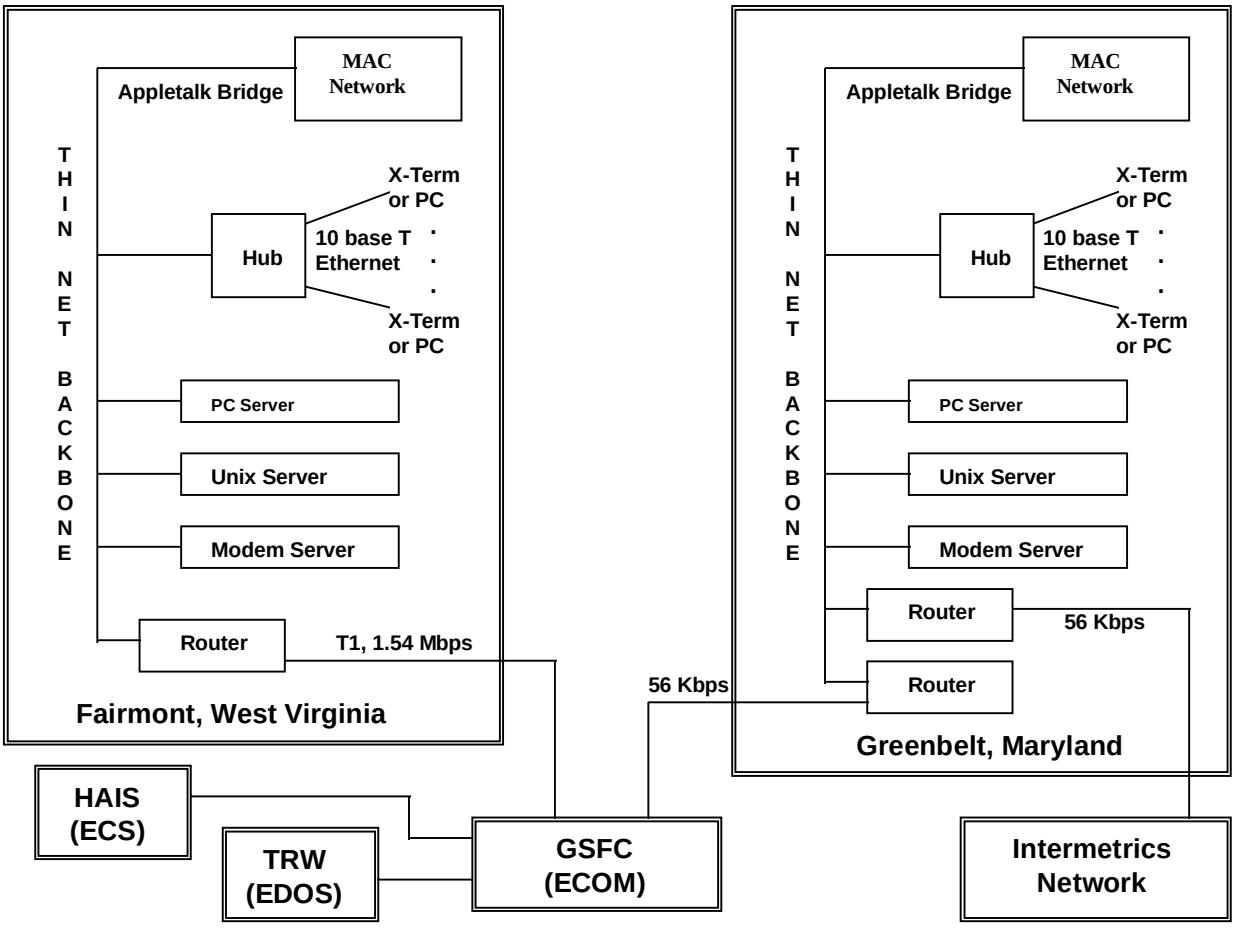

Exhibit 5-2 M1 Hardware Architecture

This exhibit illustrates the IV&V tools and their relationships to one another. The **groupware** tool is the underlying mechanism through which geographically dispersed users will achieve access to pertinent IV&V information. This "pertinent information" is created through the different classes of tools:

- Office Automation
- Management Support
- Network/Communications
- Information Tracking
- Interface Analysis
- Language Environments
- Testing

Currently, these are the classes and tools needed to support M1. As new requirements arise and as new tools are identified to fulfill these requirements, this diagram and section will be updated to reflect them.

During M1, the groupware tool will be used as much as possible to provide access to the products created by the IV&V tools. The groupware tool will be positioned now to satisfy some of the requirements identified by the IV&V tasks and to expedite the transition to M2.

The office automation tools must interface with each other by providing a mechanism to import files from, or export files to, each other. The **word processing** and **presentation** tools must be able to import files from any other IV&V tool. These tools will be used to generate briefings, reports, and formal deliverables for the IV&V effort. The **graphics** and **spreadsheet** tools will generate data, tables, and diagrams for these briefings and documents, and so they must be able to export a variety of file types.

A **project tracking** tool is required to support management. The output from this tool must export data files in a format compatible as input to the word processing and presentation tools.

The **electronic mail** (E-mail)facility will be used by team members to communicate over the LAN and WAN. E-mail messages must be accessible by the groupware product as well as the word processing and presentation tools. **File transfer** tools will be used to upload and download files to and from different platforms.

The **requirements tracing** tool will be used to track requirements throughout the various software lifecycle phases. As illustrated in Exhibit 5-1, this tool will have a relational database to support its implementation. The products created by the tool will export files that can be imported by the word processing and presentation tools.

The **interface data consistency analyzer** and **graphic communications interface analyzer** identify inconsistencies and disconnects between interfaces. The products of these tools must be exported in a format acceptable by the word processor and presentation tool.

f) The architecture must be capable of expansion in terms of processing capabilities and storage.

g) The architecture must be capable of supporting a transition to the M2 configuration without adversely impacting normal operations.

5.3 Architectural Design Description

The architectural design supports the tool requirements identified in Section 4. This support is implemented through the software and hardware designs described below.

5.3.1 Software Design

Section 4 levies requirements that drive the configuration of the IV&V tools. This configuration is illustrated in Exhibit 5-1.

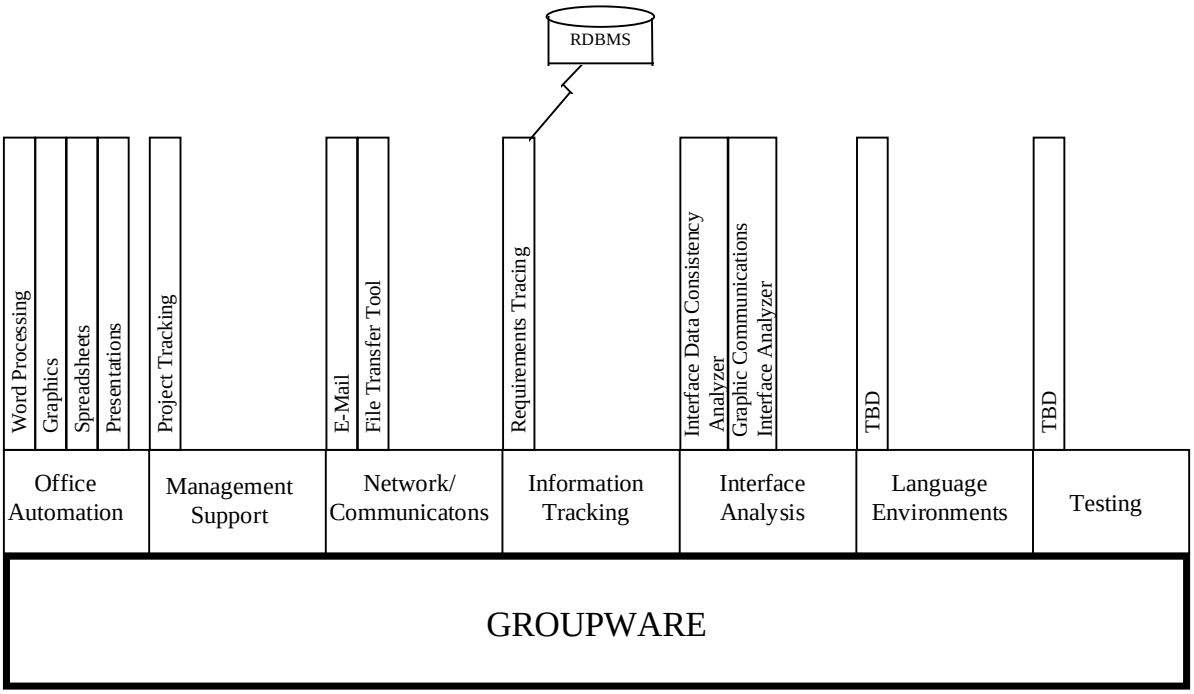

Exhibit 5-1 M1 Software Architecture

5. ARCHITECTURAL DESIGN

5.1 Purpose

The purpose of the M1 configuration is to establish an initial capability that provides fundamental support to the EOSDIS IV&V program. The M1 configuration must be capable of supporting the specific needs of IV&V tasks until M2 becomes operational in June, 1996. Section 4 of this document contains specific requirements for the IV&V Infrastructure and Tool task for the M1 operational period. This section, Section 5, describes the system level hardware and software architecture that will meet these requirements.

5.2 Design Approach and Tradeoffs

There are many factors that influence the approach used in deriving the M1 architectural design. These factors include the scope of the IV&V program tasks, the IV&V environment, and the ability to accommodate changes and facilitate transition to M2. Factors that drive the M1 architectural design include:

a) EOSDIS IV&V will be performed at multiple locations. The architecture must be capable of supporting users at Greenbelt, Maryland, Fairmont, West Virginia, or other locations (e.g., GSFC). In many cases a user must be capable of performing specific IV&V tasks regardless of their location. This will require the availability of tools at multiple locations. This availability will require either local hosting of tool applications or the use of client/server configurations with the client and server at different locations communicating across a WAN.

b) The local Greenbelt or Fairmont architecture should be similar to promote consistency of IV&V products, system performance, tool usage, and maintenance and modification.

c) There must be an ability to electronically transact mail, data, and information between Fairmont, Greenbelt, and other locations.

d) EOSDIS IV&V tasks require diverse tool capabilities. The architecture should employ standard system hardware and software resulting in an open system architecture approach that will facilitate the implementation of new and different IV&V tools and an expansion in processing capabilities.

e) The architecture must meet M1 needs while minimizing the amount of development. The approach to providing required M1 functionality is to exploit as much as possible, the capabilities of existing tools and software. In order to achieve the benefits of an integrated tool suite and increased IV&V analysis effectiveness in M2 and not delay the delivery of M2, M1 tool development will be minimized.

4.2.7 Language Environment Tools

Language support environments will not initially be required during M1. However, these environments will need to be in place when the IV&V tasks analyze the developers' systems and code, and develop additional tools for the M1 and M2 toolsets. Some preliminary requirements have been identified. Detailed requirements will be forthcoming as Task 4 proceeds with the tool identification process.

Language support environments for Ada, C, and Fortran will be required on the Sun workstations and the PCs. For each language the environments on these host computers should be mutually compatible in terms of their functionality, output, and operation.

Some of the tools that will be reviewed as requirements are assessed are compilers, linkers, debuggers, language-sensitive editors, pretty printers, source code analyzers, performance analyzers, and configuration management tools. Other language support tools may also be required.

4.2.8 Test Tools

Requirements for the IV&V test tools are in the identification and refinement phase. Test tools are important to the IV&V effort, but not until the latter phases of M1 and after the delivery of the M2 toolset. During these periods the IV&V tasks will use these tools to test the developers' software products and to certify the EOSDIS system.

Test tool requirements will need to be identified and defined for a Test Management Tool, the "Test Buddy", and the Systems Performance Dependence Analysis Tool.

Groupware
A groupware tool will be needed to archive and retrieve on-line documents in the EOSDIS library. This tool will support all tasks.

The groupware must be compatible with multiple hosts' operating systems (e.g., Unix, DOS, and, Macintosh), and it must be network shareable. To ensure the integrity and confidentiality of selected files it must provide read/write access privileges and password protection.

The groupware must provide a full on-line search capability in order to quickly locate desired information, and it must store and display data created by multiple applications. In order to support users at remote sites, the groupware must be able to transmit and retrieve data across WANs.

4.2.6 Interface Analysis Tools

Interface Data Consistency Analyzer
Software analysts will require a tool to analyze the interface definitions between evolving software items. This tool will obtain the interface requirements from text or via manual entry by the user. The tool will also allow the analyst to identify corresponding data items on both sides of the interface so the tool will know which items to compare for consistency. The tool will generate reports highlighting disconnects and inconsistencies in the interface.

In order to accept interface requirements from numerous software development activities the tool must be able to import text from a variety of word processors. Ideally, the tool should be able to digitize text from documents generated by projects external to the EOSDIS Core System (ECS). The output data should be compatible as input to the word processor for the IV&V contract.

The interface data consistency analyzer will operate on a PC tied to a LAN, and must be network shareable.

Graphic Communications Interface Analyzer
Another tool will support the analysis of the EOSDIS communications interfaces. This tool will present a graphic illustration of the EOSDIS system and its interfaces in a block diagram format and tie these graphic interfaces to a database. Analysts will populate the database with the interface standards as seen on each side of the interface. When the tool is run to analyze the interfaces, the diagram will highlight any interface with disconnects or missing items. The tool will help the analyst focus on the suspect interface and retrieve data to resolve the problem.

This tool will be able to import files from a variety of word processors. Its graphic output should be importable by the IV&V word processor.

This tool will be hosted on a PC and will be shared by multiple users on the LAN.

The Transition Engineering Database (TENDB), another custom tool developed in-house, is a candidate to fulfill these requirements.

File Transfer Tool
A file transfer tool will transfer various types of data files between different host computers on the local and wide area networks. These computers will include Unix, DOS, and Macintosh operating systems.

4.2.4 Information Tracking Tools

Requirements Tracing
Tracing software requirements from requirements definition through software testing and maintenance is a key part of the IV&V effort. A proven requirements tracing tool will be critical to the performance of all tasks in the IV&V process.

Verification of each step in the software lifecycle requires that the tool will be able to trace requirements through all four levels of the EOSDIS requirements specifications and to other specifications at the same level. The tool must also trace requirements through the design, implementation (i.e., code), test plans, test procedures, test results, and the change requests and discrepancy reports that follow.

The requirements tracing tool will be resident on workstations tied to a network and must be network shareable. The output data will be compatible as import data for the word processing tool.

The requirements tracing tool must be able to link to external databases resident on servers and separate PC LANs and export/import data to/from EOSDIS developers at remote sites. The tracing tool should also connect to the Internet in order to acquire electronic copies of documents.

In order to permit editing of elements in the requirements database, the tracing tool will permit execution of attached applications (e.g., MS Word, MS Excel, Lotus Notes).

It would be highly desirable for the tool to have the ability to trace Interface Requirements Documents (IRD) and to establish linkage to numbered data flows in the Architecture Definition Document and in the EOS Ground System Architecture Document.

Due to the critical role of this tool, NASA has specified that the IV&V contractor will use the Requirements & Traceability Management (RTM) tool, a mature COTS tool with demonstrated capabilities.

4.2.5 Database Tools

Relational Database Management System
A relational database management system (RDBMS) will be required to support the requirements tracing tool. This database must be hosted on the Sun workstations and PCs, and it will be accessible on the WAN serving West Virginia and Maryland.

This RDBMS must also be compatible with Oracle, the RDBMS being used by the EOSDIS developers.

Graphics
All tasks will have a need to generate graphics to illustrate status reports and other contract deliverables. The graphics tool should operate on both Macintoshes and PCs.

The graphics tool must be able to save its files in a format that can be imported by the word processor, and it must be compatible with the graphics tools used by NASA and the EOSDIS system developers.

Spreadsheets
A tool that produces spreadsheets will be needed to capture and calculate numerical data for financial and status reports. It will operate on Macintoshes and PCs.

This tool must be able to link multiple spreadsheets, cross-calculate totals, and present data in multiple graphic formats. The format of the spreadsheet files must be compatible as imports to the word processor.

Presentations
All tasks in the SOW will require a tool to create briefing charts for presentations. This tool will operate on both Macintoshes and PCs.

This tool will have the capability to create and store templates for briefing slides. It will be able to generate line art and import files from the selected graphics tool. It should also support color output.

4.2.2 Management Tools

Project Tracking
This tool will be used to track all contract tasks and report their status via graphic displays. It will operate on a Macintosh computer, and it will have the ability to receive input from multiple users.

The project tracking tool will satisfy several key requirements. It will interface with and transfer data to Artemis Prestige by Lucas Management Systems, and it will be shareable to multiple users on the network. It will provide PERT and Gantt charts with critical path analysis, track resource allocations, calculate earned value by task, and interlink data from multiple projects.

4.2.3 Network/Communication Tools

E-Mail
This tool will allow IV&V personnel to communicate with each other, the EOSDIS system developers, and NASA personnel via networks for local and remote sites.

This tool must be compatible with multiple hosts, and it must be able to access the Internet and other wide-area networks (WANs). It must be able to enclose all types of data files.

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10
	Project Management	Document & Presentation	IV&V Plans	Infrastructure & Tool Development	Requirements Analysis & Traceability	ECS Interim Release 1 Development Analysis	ECS Release A Development Analysis	ECS Release A IV&V Testing	Key Interface Analysis	EOS Ground System Certification Plan
Word Processor	X	X	X	X	X	X	X	X	X	X
Graphics	X	X	X	X	X	X	X	X	X	X
Spreadsheets	X	X	X	X	X	X	X	X	X	X
Presentations	X	X	X	X	X	X	X	X	X	X
Project Tracking	X	X	X	X	X	X	X	X	X	X
E-Mail	X	X	X	X	X	X	X	X	X	X
File Transfer	X	X	X	X	X	X	X	X	X	X
Requirements Tracing					X	X	X	X	X	
RDBMS					X	X	X	X	X	
Groupware	X	X	X	X	X	X	X	X	X	X
Interface Data Consistency Analyzer									X	
Graphics Communication Interface Analyzer									X	
Language Environment Tools				X		X	X	X		
Test Tools				X		X	X	X		

Exhibit 4-1 The SOW Tasks Require Several Classes of Tools

This section presents the functional requirements for each tool class. The requirements for each class were compiled by identifying each of the ten task's specific requirement for this class of tool. Therefore, the composite set of requirements that have been gathered for a particular class may provide more capabilities than required by a specific task, but any tool that meets all of the requirements will satisfy the needs of any task.

Our tool selection process will rely on these requirements in the process of evaluating, comparing, and choosing the best tools for this contract. However, in some cases NASA has already mandated specific tools for the IV&V contract in order to maintain compatibility with the tools currently in use by the EOSDIS developers or by NASA itself.

4.2.1 Office Automation Tools

Word Processing

Word processors will be used extensively by all tasks to produce reports and contract deliverables for the EOSDIS IV&V contract. They will operate on both Macintosh and PC computers, and they will frequently be used to integrate text and graphics generated by multiple users at various remote sites.

The word processing tools will have to satisfy several requirements to properly support the contract. This tool will operate on Macintosh and PC computers tied to local area networks, and the word processor will be network shareable. File transfers between the Mac and PC will be relatively transparent.

During the course of the contract, tasks in the SOW call for the delivery of large reports with numerous figures and tables. To support these deliverables, the word processor must be able to handle documents in excess of 200 pages, and it must have the ability to generate and import graphics and tables. The word processor will provide the capability to create and store document templates so multiple authors can follow a common format. The word processor must also be able to automatically generate a table of contents and lists of tables and figures.

The EOSDIS IV&V team will work closely with the EOSDIS system developers and NASA to ensure the IV&V system architecture is designed to promote accessibility and interoperability from remote sites. In compliance with this objective, it will be important for the IV&V word processor to be compatible with those used by the developers and NASA. However, to ensure the integrity and confidentiality of selected files in this open architecture, the word processor must support password protection and read/write access control.

4. Tool Requirements

4.1 EOSDIS IV&V Program Requirements

The IV&V toolset for M1 will provide the initial capabilities required to perform the technical and managerial tasks presented in the Statement of Work (SOW) for the EOSDIS IV&V contract. A basic set of documentation and contract management tools will be available and operational at contract start to support initial tasks and deliverables. This set will include tools for word-processing, presentations, planning and scheduling, and task and cost tracking.

The M1 tools will be required to operate on one or more of a variety of personal computers[1] (PC) at the IV&V Facility in Fairmont, West Virginia and the Intermetrics' office in Greenbelt, Maryland. These PCs will eventually be tied to networks that will link these sites and provide both contractor and customer direct access to tools and data resident at remote sites.

During the first 18 months of the contract the M1 toolset will undergo a phased development which will establish the foundation for the comprehensive, fully integrated M2 toolset. Consequently, the M1 tools will be selected or developed to be compatible with the M2 system design as much as possible. This requirement will reduce or eliminate the need to modify or replace these tools and their associated processes during the transition to M2.

The phased development of the M1 toolset will be marked by demonstrations of the initial and revised versions of the toolset at 4, 6, 12, and 18 months after contract start. These tools will continue to support the project until the M2 system is completed and demonstrated at month 24.

The M1 tools should satisfy some basic requirements in order for the EOSDIS IV&V contract to be successful. They should be reliable, easy to use, cost efficient, and available for use at or shortly after contract start. Consequently, these requirements mandate that most of the M1 tools be Government Off-The-Shelf (GOTS), Commercial Off-The-Shelf (COTS), or previously developed and proven contractor software. The objective is to minimize development costs and the risks associated with new software tools by acquiring existing tools with proven track records. Tools will only be modified or developed when requirements cannot be met by currently available tools.

Other requirements important to the M1 toolset are ease of use and the mutual compatibility. User-friendly tools curtail or eliminate training costs and enable the user to efficiently generate quality products. Mutually compatible tools that can import products from other tools can be acquired to form a versatile, loosely-integrated toolset.

4.2 Functional Requirements

The functional requirements for the M1 tools are dictated by the ten tasks described in the SOW. These tasks require several classes of tools, and, as illustrated in Exhibit 4-1, many tasks require the same classes.

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[1] In this document "PC" refers *specifically* to an IBM DOS PC or an IBM clone.

consolidated by the team POC and placed into the tool's evaluation folder and passed to the next activity.

Evaluate Products

Perform a hands-on evaluation to complete the criteria checklist. If any of the tools demonstrated were severely inferior to the others, then they should be removed from the list of candidates. The tool folders created for the inferior products are filed, because the tool identification team may one day need to re-evaluate that tool and this will provide a good starting point. Once this is done, the team POC for each tool should contact the remaining vendors about acquiring evaluation copies (this can be accomplished at the demonstration to avoid further delay). Once the team acquires the evaluation copies, each team member works with each tool to complete the non-critical criteria. Notes are captured and provided to the team POC. The team POC should have several complete tool files which contain:

- completed criteria checklists
- general tool and vendor information
- vendor point of contact
- any notes taken during demonstrations or evaluations

These tool folders are provided to the next activity.

Provide Recommendations

Provide management with a recommended tool based on the results of the process. The tool identification team lead gathers the files for a given category of tools. The lead examines the scores and notes and develops a formal recommendation to provide to management. Management will use this recommendation along with other factors (e.g., cost, corporate goals) to make a final decision on the tool selection. The tool folders are filed so that others may draw upon the knowledge and insight that was gained by the tool identification team. Also, the identification team may need to re-evaluate the tools at a later date and these folders will provide a good starting point.

Formal criteria are developed for all future evaluations. The tool requirements and desirable tool attributes, created by the Identify Requirements activity, are input into the develop criteria activity. From these inputs, the tool identification team will develop a list of criteria divided into two categories: *critical* and *non-critical*. Critical criteria are the minimum task requirements the tool must meet. Non-critical criteria are means to measure tools against each other. These include less tangible criteria such as learning curve, user friendliness, product support, and training. The non-critical criteria will have weights assigned to them to help differentiate the tools (critical criteria do not need weights, as each is a requirement and thus a disqualifying factor). These criteria are developed with the help of the task(s) that originated the requirements and desirable attributes. Many meetings, conversations, and user-scenario descriptions are required to clearly identify the deciding criteria upon which tool selection is based. Establishing robust criteria is most important as these criteria will be used throughout the remainder of the process.

3.2.2 Tool Evaluation Phase

The Evaluation Phase receives the criteria generated in the previous phase as input. The Identification Team will use the criteria to help complete the four activities of the Evaluation Phase: **identify candidates**, **schedule demonstrations**, **evaluate products**, and **provide recommendation(s)**.

Identify Candidates

Potential tools are selected and corresponding tool vendors are contacted for product information. The tool identification team identifies the tools, and their corresponding vendors, to be evaluated. The term "vendors" does not limit the team to merely the commercial industry; they may also draw upon Government Off-The-Shelf (GOTS) products or in-house products. Once an initial list is selected, the requirements portion of the criteria is applied to these tools. If any fail to meet these requirements then they are removed from the list of candidates. The goal of this activity is to narrow the list of candidates to a number that the team can evaluate in a reasonable time period. If, after applying the criteria, the number of candidates is too large, the identification team lead will narrow the list. The list of leading candidates, including a point of contact and general tool and vendor information are provided to the next activity. A file or folder is established for each candidate. This file is used to hold all tool information and completed criteria.

Schedule Demos

Contact leading candidates to schedule tool demonstrations. One team member is identified as the point of contact (POC) for a given tool. This team member is responsible for contacting the tool vendor to schedule a formal demonstration. These formal demonstrations are intended for the appropriate tool identification team members, key members from the task(s) identifying the tool requirements, and any needed management. The team POC will provide information (e.g., project context and tool requirements) to the vendor so the demonstration is targeted towards the project's needs. The team POC may want to send a copy of the criteria to the vendor, so the vendor can address the criteria themselves. During the demonstration, each team member should capture notes and complete the checklists (if necessary). These notes are gathered and

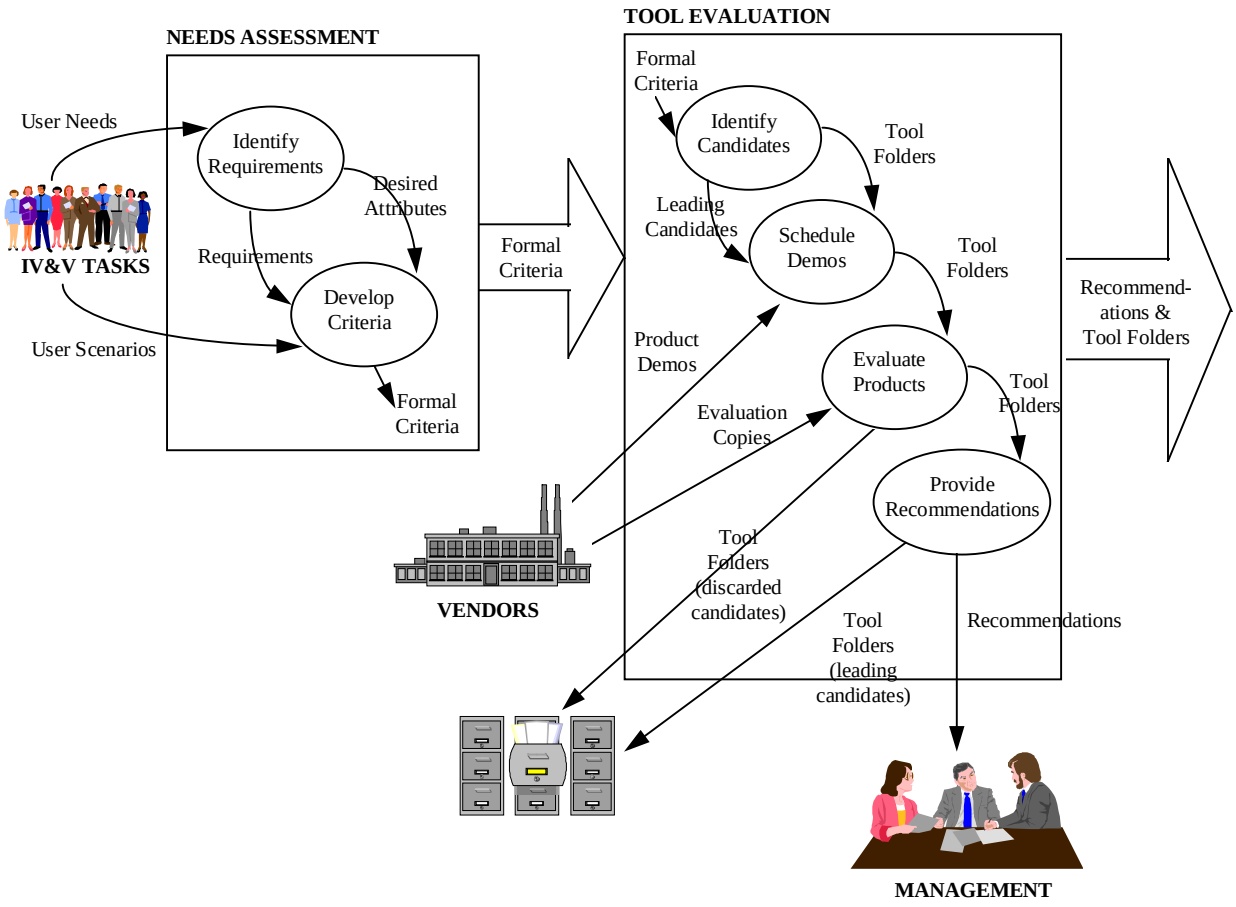

Exhibit 3-1 Tool Identification Process

3.2.1 Needs Assessment Phase

The Needs Assessment Phase produces a formal set of criteria that is used to evaluate potential tool solutions. This phase consists of two activities **identify requirements** and **develop criteria** to help produce the formal criteria. Both are explained below:

Identify Requirements

Tool requirements are captured and refined. Tool needs are communicated by the task members to the tool identification team. These needs identify the category of tool (e.g., word processor, requirements traceability tool), other relevant requirements (e.g., platforms, compatibility with other tools), and desired attributes (e.g., user friendly, small learning curve). The tool identification team captures these needs, separates the requirements from the desired attributes, and formally documents each. Both the requirements and the desirable attributes will be input into the next activity.

Develop Criteria

3. TOOL IDENTIFICATION PROCESS

3.1 Purpose and Scope

The purpose of this section is to describe the EOSDIS IV&V tool identification process in order to clarify how the requirements and architecture defined in this document will be used to acquire IV&V tools. The process provides guidelines to assist IV&V team members in evaluating and selecting tools.

3.2 Description

The tool identification process for the EOSDIS IV&V contract draws from Intermetrics' IV&V experience over the past two decades. This process encourages innovative application of automation that reduces labor intensive activities and promotes information integrity in a cost-effective manner. As the tool identification team applies this process any lessons learned will be captured and applied to the process. Thus, the process is continually improved and updated. As with any process, not all the steps will apply to every situation. If the tool identification team recognizes such a situation, the justification for stopping or deviating from the process will be documented and the team will move forward. Also, when tools have been predetermined (e.g., NASA selected, Intermetrics standard), the process will be terminated early. The process is intended to be a guide to help the tool identification team, not a hindrance or a bureaucracy to slow progress. The extent of West Virginia University (WVU) participation in the tool selection process will be defined in a pending Memorandum of Understanding.

The tool identification process consists of two phases: **needs assessment** and **tool evaluation**. During the needs assessment phase, requirements for tools are identified and the criteria to base tool evaluations are developed. The tool evaluation phase is responsible for applying that criteria, completing a hands-on evaluation, and providing tool recommendations. Exhibit 3-1 illustrates the process, its two phases, and the division of those phases into activities. The inputs and outputs of the activities and phases is provided as well. Although these are two separate phases, they cannot be accomplished in parallel. The outputs from the needs assessment phase must be complete to ensure the success of the evaluation phase.

2.2 Applicable Documents

The following documents are referenced herein and are directly applicable to this volume:

1. "Statement of Work for the Independent Verification and Validation (IV&V) of the EOS Data and Information System and Key EOS Ground System Interfaces", dated April 19, 1993

2. "NASA Software Documentation Standard Software Engineering Program" NASA-STD-2100-91, dated July 29, 1991

2. RELATED DOCUMENTATION

2.1 Parent Documents

The following documents are parents to this document:

1. "Earth Observing System (EOS) Performance Assurance Requirements (PAR) for the Independent Verification and Validation (IV&V) of the EOS Data and Information System (EOSDIS)", GSFC 420-05-05, dated March 23, 1993

2. "Independent Verification Validation Management Plan (IVVMP)", dated TBD

3. "Independent System Verification & Validation Plan (ISV&VP)", dated TBD

4. "EOSDIS IV&V Task 1 IV&V Project Management Statement of Work", dated June 16, 1994

5. "EOSDIS IV&V Task 2 Documentation and Presentation of IV&V Program Status Statement of Work", dated June17, 1994

6. "EOSDIS IV&V Task 3 Independent Verification and Validation Plans Statement of Work", dated June 16, 1994

7. "EOSDIS IV&V Task 4 IV&V Infrastructure and Tool Development Task Statement of Work", dated June 16, 1994

8. "EOSDIS IV&V Task 5 Requirements Analysis and Traceability Task Statement of Work", dated June 16, 1994

9. "EOSDIS IV&V Task 6 ECS Interim Release 1 Development Analysis Task Statement of Work", dated June 16, 1994

10. "EOSDIS IV&V Task 7 ECS Release A Development Analysis Task Statement of Work", dated June 16, 1994

11. "EOSDIS IV&V Task 8 ECS Release A IV&V Test and Test Scenario Generation Statement of Work", dated June 16, 1994

12. "EOSDIS IV&V Task 9 Key Interface Analysis Statement of Work", dated June 16, 1994

13. "EOSDIS IV&V Task 10 Development of EOS Ground System Certification Plan Statement of Work", dated June 16, 1994

Section 5 explains the ***architectural design*** including both the hardware and software design. The hardware design provides the configuration and specifications of the components. The software design explains how the IV&V tools relate to each other.

Section 6 describes the ***future actions*** that are a result of the completion of this document.

Section 7 contains a list of ***abbreviations and acronyms*** used in this document.

1. INTRODUCTION

1.1 Identification of Document

This is the Earth Observing System Data and Information System (EOSDIS) Independent Verification and Validation (IV&V) Requirements and Architecture Document for the Milestone 1 (M1) IV&V Infrastructure and Tools.

1.2 Purpose and Scope of Document

This document is concerned with the M1 portion of the IV&V Infrastructure and Tools. M1 must satisfy initial tool requirements, identify tools for current and near-term tasks, and network IV&V locations. This document defines the high level software tool requirements resulting from a needs assessment, a tool identification process describing the formulation and use of these requirements, and the system level hardware and software architecture requirements. These requirements are input into establishing formal criteria used to identify, evaluate, and recommend tool solutions. The need and use of these requirements are explained in Section 3, Tool Identification Process. M1 will be a foundation for the Milestone 2 (M2) configuration which becomes operational after 24 months.

1.3 Document Status and Schedule

Following initial delivery of this document, subsequent deliveries will be made to support the evolving needs of EOSDIS IV&V Tasks. There are planned revisions of M1 at 6, 12 and 18 months from contract start on June 16, 1994. This requirements document will reflect these revisions.

1.4 Documentation Overview and Organization

This document presents the high level tool requirements and the hardware and software architecture for M1. In addition, a tool identification process is provided, which the IV&V Task 4 team will use as guidelines to help select the proper tools. This document will be periodically updated to reflect any new M1 requirements identified or any improvements to the tool identification process.

Section 1 establishes the context of the document through an ***introduction***. This identifies the document, the scope and purpose of the document, and the status of the document.

Section 2 lists the ***related documentation*** including parent documents and applicable documents.

Section 3 describes the ***tool identification process*** which will be used by the task 4 team to evaluate and select tools.

Section 4 details the ***tool requirements*** for the ten M1 IV&V tasks. As new tasks are initiated, new tool requirements will be identified and captured and this document updated.

Terminals) linked together on a thinnet backbone and 10baseT ethernet local-area network (LAN) at each IV&V site. The IV&V sites, Fairmont and Greenbelt, are connected via a wide-area network (WAN). This architecture provides the necessary framework for the IV&V tasks to perform their work.

As the EOSDIS program progresses, tasks may be added to the IV&V resulting in new M1 requirements and revisions to the configuration. Scheduled revisions of M1 exist at 6, 12, and 18 months from contract start, June 16, 1994. This document will be updated to reflect these revisions to help the IV&V effort realize its goals.

SUMMARY

The primary objective of the Milestone 1 Requirements and Architecture document is to define the EOSDIS IV&V infrastructure and tool requirements to support Milestone 1 (M1) as well as define a process for tool evaluation. The M1 system level hardware and software design (infrastructure) and tools provide the computational resources to satisfy the immediate task needs until the integrated toolset, Milestone 2 (M2), is available. To meet these immediate needs, M1 will primarily consist of existing off-the-shelf software with minimal in-house development. The tool identification process provides the guidelines for selecting appropriate tool solutions. This M1 toolset will establish the foundation for M2; thus, the tools identified for M1 will be compatible to the M2 design, as much as possible.

The tool identification process is in place to help the IV&V tool identification team select a cost effective "best of breed" tool suite. This process will further evolve into a robust set of guidelines that can be used throughout the IV&V project lifecycle. The process is a two phased approach: ***needs assessment*** and ***tool evaluation***. During the needs assessment phase, tool requirements and desirable attributes are captured and formally documented. The tool identification team then converts these requirements and attributes into formal criteria that each candidate tool will be weighed against. These criteria are provided to the next phase, tool evaluation. During this phase, candidate tools are identified and their corresponding vendors are contacted for product information. Formal tool demos are held and eventually, evaluation copies of tools are acquired. During these activities, the number of candidates diminishes as the weaker candidates fall by the wayside and the lead candidates rise to the top. Once all the evaluations are complete, the tool identification lead provides a formal recommendation to management.

The first phase of the tool identification process requires the tool identification team to capture and document the tool requirements; this document is a result of the first phase. The requirements of the IV&V tools to support M1 are dominated by tools with a project support flavor -- all of the tasks have identified the need to perform word processing, file transfer, project tracking, and to generate graphics, spreadsheets, presentations, and electronic mail (E-mail). The tasks have also identified a need to share information at the two geographically dispersed sites, Fairmont, WV and Greenbelt, MD. This will be accomplished by groupware and the hardware architecture solution. The more specific tool needs include a requirements tracing tool, an interface data consistency analyzer, and a graphics communication interface analyzer. The tool identification team recognized the need for language environments and test tools in the future. As the needs for these two tools are communicated, the identification team will update the document to reflect the requirements.

This document explains the IV&V infrastructure by describing the hardware and software architectures. The software design explains how the tools are integrated to work together. Although complete tool integration is not a goal of M1, some integration is needed to satisfy the needs of the tasks. This integration is elementary -- e.g., the word processing tool needs to import and export files from and to the graphics package; the presentation manager needs to import files from the graphics package. The hardware design supports the proposed software and tool requirements on an assortment of platforms (e.g., File Servers, PC's, Macintoshes, and X-

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EOSDIS IV&V

MILESTONE 1

REQUIREMENTS AND ARCHITECTURE

EOSDIS IV&V INFRASTRUCTURE AND TOOLS

July 15, 1994

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MILESTONE 1

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